

4. (New) A method for filling a plurality of contact holes in a semiconductor device with metal, comprising:

depositing a first and a second metal layer on a gate electrode associated with a first contact hole in a first and a second distinct metal-deposition steps respectively and depositing a ^{second} ~~first~~ metal layer on a conductive layer pattern associated with a second contact hole subsequent to the deposition of the first metal layer associated with said first contact hole.

5. (New) The method of claim 4, wherein the metal layers are formed by chemical vapor deposition method.

6. (new) The method of claim 4, further comprising depositing a first and a second metal layer on a junction layer concurrently with the deposition of the first and second metal layer on the gate electrode.

REMARKS

Reconsideration and withdrawal of the rejections is respectfully requested.

Claim 2 has been amended to clarify that the second metal layer was formed subsequent to the formation of the first

metal layer. Support for this amendment is found in the specification on page 5, line 17 to page 6, line 2. No new matter has been added.

New claims 3-6 have been added. Support for these claims are found in the specification on page 2, line 26 to page 3, line 16, and original claims 1 and 2. No new matter has been added.

Claim 1-6 are pending.

The Examiner has included copending patent applications S/N 08/038155, 07/983875, and 08/016597 on Form 1449. These patent applications were brought to the Examiner's attention for the purpose of informing the Examiner that these applications are commonly assigned and not as prior art. Removal of said applications from Form 1449 is respectfully requested.

Rejection Under 35 U.S.C. § 112, Second Paragraph

The Examiner rejected claim 2 as being indefinite because the Examiner perceived that the exact order in which the contact holes are formed and filled is not clear from the claim language of claim 2. Applicants have amended claim 2 to clearly indicate that the second metal layer in the contact holes are formed subsequent to the formation of the first metal layer. Therefore, Applicants submit that the exact order of the formation of the metal layers in the contact holes are clearly

delineated in the amended claim 2. Removal of the rejection is respectfully requested.

35 U.S.C. § 103 Rejection

The Examiner rejected claims 1 and 2 as being unpatentable over admitted prior art in view of Shishino (JA 0034929) and Tanaka (JA 0165320). Applicants respectfully traverse the rejection.

The Examiner asserted that the differences between the admitted prior art and the claims are: filling the contact holes by a method in which the selective tungsten thin films are deposited in two steps and it would have been obvious to one of ordinary skill in the art to modify the admitted prior art by using a two step metal thin film deposition process as suggested by Shishino and Tanaka. Applicants respectfully disagree.

The Shishino (JA 0034929) Reference

The Examiner asserted that the Shishino reference teaches at the abstract that it is new in the art to fill a contact hole with a metal or metals using a two step deposition process and that one in ordinary skill in the art can use this method to modify the admitted prior art because depositing the metal in two steps prevents short circuiting and improves the reliability of the wiring. However, the method disclosed by

Shishino is very different from the present invention in the objective, construction, and effect.

First, Shishino does not disclose depositing metal to form contact holes with different depth. As a matter of fact, only one contact hole is shown. In contrast, the present invention is particularly useful for filling a plurality of contact holes. Second, there is only one insulation layer (4) in the device of Shishino. The present invention is particularly in application in filling contact holes in multiple insulation layers.

The device as disclosed by Shishino is completely unrelated to overcoming troublesome problems associated with the different of surface topography in contact holes, i.e., contact holes with different depths. In forming the device of Shishino, a hole (5) is first formed and subsequently partly filled by growing a tungsten layer in the hole, followed by a selective electroless plating of a layer of copper (7) on the surface of the tungsten layer (6). The objective of this method was to present a smooth surface effected by forming the layer of copper, since the surface of tungsten layer (6) grown by the chemical vapor method is very hard and regular. There is no indication that the vapor deposition method can be used to fill a hole from the bottom of the hole to the top to form an effective contact hole. In fact, since a copper layer is used to fill the top part of the contact hole, Shishino teaches away from filling the top

of a contact hole with a vapor deposition method. There is absolutely no indication, teaching, or suggestion that how first depositing a tungsten layer in hole to partly fill the hole and subsequently forming a copper layer in the same hole by electrode plating can be modified to overcome the problem encountered by effectively depositing metal layers in holes with different depths.

Shishino's disclosure absolutely does not recognize the problem created by the difference of depth between adjacent contact holes. In a semi-conductive device having holes with different depths, in an effort to fill the holes so that all of the contact holes have an effective metal layer deposited therein, the metal layer in the upper portion of a shallow contact hole will get filled first and may grow sideways on the surface of the device as the deeper holes are being filled. This kind of sideways growth of a metal layer in a contact hole greatly increases the risk of short circuiting the semi-conductive device. There is no indication that Shishino recognized such a problem in the formation of semiconductive devices with contact holes of different depths, and gave no suggestion as to how solve such a problem. The recognition of a problem has an impact on patentability.

Even if, Arquendo, assuming Shishino recognizes such a problem, there is no indication that Shishino's method can be modified to fill holes with different depths. Shishino only

teaches a two step method in filling a hole, it absolutely gives no indication that their method can be applied to a plurality of contact holes, wherein some of said contact holes are shallower than others.

The Tanaka (JA 0165320) Reference

The Examiner asserted that Tanaka teaches at the abstract that it is known in the art to fill a contact hole by forming a first insulating layer on a substrate surface, removing a portion of the first insulating layer to expose the surface of the substrate, and filling the first contact hole with a metal; then forming a second insulating layer on the substrate surface, removing a portion of the second insulating layer to expose the first metal, and filling the second contact hole with a metal. Applicants respectfully submit that the method and device disclosed by Tanaka is also very different in their objective, construction, and effect from those of the present invention.

First, there is no indication that Tanaka is related to vapor deposition method in any way. Second, as in Shishino, Tanaka does not disclose a method for making a device wherein contact holes have different depths, since all the holes that are shown to be filled in the patent have the same depth. There is no indication that Tanaka (as Shishino had not) recognized the problem associated with depositing a metal layer in adjacent contact holes that have different depths. Tanaka's invention was

for the purpose of etching contact holes and providing a monitoring hole at the same time. There is no teaching or suggestion by Tanaka on how their method can be modified to overcome a problem wherein contact holes have different depths..

Moreover, Tanaka, as Shishino, does not disclose the deposition of a metal in a second contact hole after the deposition of a metal layer in a first contact hole, which is at a different location (i.e., spaced) from the second contact hole. In the present invention, Applicants discovered that the solution of the problem of depositing a metal layer in adjacent contact holes with different depths is the deposition of a metal layer in a contact hole associated with a gate electrode before deposition of a metal layer in another contact hole associated with a conductive layer pattern. This sequential deposition of metal layer in holes of different depths is effected in the present application by forming the contact hole (i.e., the contact hole associated with conductive layer pattern) only after a contact hole has been formed and filled with a metal layer in a location associated with a gate electrode. Tanaka neither teaches or suggests such a formation and initially filling of second contact hole only after the deposition of metal layer in a first hole spaced from the second contact hole.

In sum, neither Shishino nor Tanaka recognizes the problem facing depositing a metal layer in holes with different

depths. Neither patent teaches or suggests the formation of contact holes (i.e., second contact hole which are spaced from the first contact holes) only after the formation and deposition of a metal layer in a first hole. Such a new feature is also not disclosed in the prior art drawings, Figs. 1A and 1B, disclosed in the present invention. Applicant respectfully submits that neither Tanaka nor Shishino indicates how their method of forming a semi conductive device can be modified to overcome the problem of preventing the growth of a metal layer sideways in shallow contact holes when contact holes with different depths are being filled with a metal layer. No combination of the disclosure shown in the prior art Figs. 1A, 1B and the patents of Tanaka and Shishino can led to a method wherein a second contact hole is formed and filled with a metal only after a first contact hole spaced from the second contact hole has been formed and filled with a metal layer. Therefore, Applicants respectfully submit that the disclosure of prior art Figs. 1A, 1B and the patents of Tanaka and Shishino can not be properly combined to render the presently claimed invention obvious. Accordingly, withdrawal of the rejection is respectfully requested.

In view of the foregoing amendments and remarks, Applicant submits that the pending claims of the present application are now in condition for allowance and such action is earnestly sought. If the Examiner believes that any points at issue on the application could best be resolved by either a

personal or a telephone interview, the Examiner is urged to contact the undersigned Applicant's attorney at the number listed below. Please charge any additional fees and credit overpayments to deposit account 13-2725.


Respectfully submitted,

Sang Young KIM et al.


By their attorneys,

MERCHANT, GOULD, SMITH, EDELL,
WELTER & SCHMIDT, P.A.
3100 Norwest Center
90 South Seventh Street
Minneapolis, MN 55402
(612) 332-5300

By


Philip S. Yip
Registration No. 37,265
PSY:lmg

I hereby certify that this correspondence is being deposited with the United States Postal Service as first class mail in an envelope addressed to the Commissioner of Patents and Trademarks, Washington, D.C. 20231 on January 21, 1994.


Philip S. Yip